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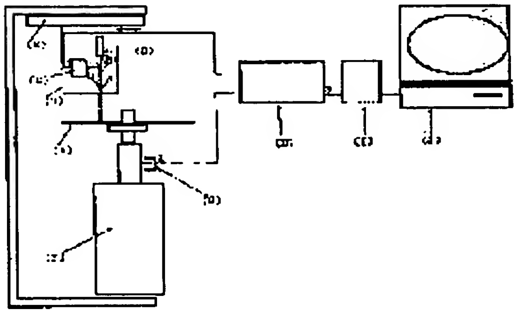
(54) WARPAGE MEASUREMENT METHOD AND DEVICE FOR DISK

(57)Abstract:

PROBLEM TO BE SOLVED: To measure the peripheral and radial two-dimensional warpage of a disk via a single one-way position transducer element by calculating a disk warpage amount on the basis of the radial warpage angle of the disk.

SOLUTION: Spots irradiated to the surface of a disk A from an irradiation means B are relatively moved in a radial direction on the light reflection surface of the disk A by means of a parallel displacement means E, with the disk A kept rotating with a rotary means F. Signals for the positional change of reflected light due to the radial warpage of the disk A, and signals for rotating positions from a rotation position read means G are composed by use of a signal composing means H. The signals so composed are stored in a signal recording means I, and the stored signals are computed by an arithmetic processing means J, thereby measuring the warpage of the disk A. According to this construction, only one unidirectional position transducer element is used to find a peripheral warpage angle from information regarding the radial warpage. As a result, warpage angles in two directions can be concurrently measured in a single operation.



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CLAIMS

[Claim(s)]
[Claim 1] An exposure means to be the approach of measuring the curvature configuration of a circular disk (A) of having light reflex nature, and to irradiate laser light from a perpendicular direction continuously to the front face of said disk (A) (B), It has an one direction location detection means (C) based on the radial curvature of said disk (A) to detect the deflection from the specular reflection location of said reflected light. And the relative position of said exposure means (B) and said reflected light detection means (C) is being fixed. The means in which is the thing (a detection head (D) is called below) of integral construction, and either said detection head (D) or said disk (A) carries out a parallel displacement relatively [radial / of said disk (A)] (E), A means (F) to rotate said disk (A), and a means to read the rotation location of said disk (A) (G), A means to compound the signal from the location detection means (C) of said reflective beam, and said rotation location reading means (G) (H), A means to extract the signal from said signal composition means (H) with a fixed time interval, and to record said extracted thing (I), The spot which irradiated the front face of said disk (A) from said exposure means (B), having the means (J) which carries out data processing of said recorded signal, and rotating said disk (A) with said rotation means (F) with said parallel displacement means (E) the signal showing location change of said reflected light resulting from the curvature of said disk (A) radial [at the time of making radial displaced relatively in respect of the light reflex of said disk (A)] -- and By compounding the signal showing the rotation location from a rotation location reading means (G) with said signal composition means (H), and calculating the signal which saved and saved the signal after composition for said signal record means (I) with said data-processing means (J) Are the measuring method which measures the curvature of said disk (A), and started record with said signal record means (I). The field which intersects said incident light and perpendicular is made into datum level including the predetermined location by the side of the inner circumference of said disk (A). Make into origin of coordinates the point that said datum plane and said disk revolving shaft cross, and the value of the curvature in the scan location in the first round is disregarded for convenience the inner circumference side of said disk (A). It is based on the information corresponding to the first round of said output signal record means (J). Calculate the amount of displacement in the 2nd-round scan location, and it is based on the information corresponding to the n-th round like the following. The amount of displacement in each scan location for which calculated the amount of displacement in the n+1st-round scan location, and it asked one after another by this sequence by adding on the same radius The curvature measuring method of the disk characterized by finding the distance T (it being described as the amount T of curvatures below) from said datum level in the radius location and the angular position of said disk (A), and computing the camber angle of a circumferencial direction from the geometric relation based on said amount T of curvatures in each scan location.
[Claim 2] The semiconductor laser which is equipment which measures the curvature configuration of a circular disk (A) of having light reflex nature, and irradiates laser light from a perpendicular direction continuously to the front face of said disk (A) (b), It has the single dimension location sensing element (c) which detects the deflection from the specular reflection location of said reflected light based on the radial curvature of said disk (A). And the relative position of said semiconductor laser (b) and said single dimension location sensing element (c) is being fixed. The 1 shaft movable slider in which is the thing [a detection head (d) is called hereafter] of integral construction, and either said detection head (d) or said disk (A) carries out a parallel displacement relatively [radial / of said disk (A)] (e), The rotation pulse generator which generates the rotation pulse signal which expresses the rotation location of said disk (A) as the motor (f) turning around said disk (A) (g), The signal composition circuit which compounds the signal from said single dimension location sensing element (c) and said rotation pulse generator (g) (h), The analog-to-digital

converter which extracts the signal from said signal composition circuit (h) with a fixed time interval, and records said extracted thing (i), Having the computer (j) which carries out data processing of said recorded signal, and rotating said disk (A) by said motor (f) The spot which irradiated the front face of said disk (A) from said semiconductor laser (b) with said 1 shaft movable slider (e) the signal showing location change of said reflected light resulting from the curvature of said disk (A) radial [at the time of making radial displaced relatively in respect of the light reflex of said disk (A)] -- and The signal showing the rotation location from said rotation pulse generator (g) is compounded by said signal composition circuit (h). Save the signal after composition at said analog-to-digital converter (i), and by calculating the saved signal by said computer (j) Are the measuring device which measures the curvature of said disk (A), and started record with said analog-to-digital converter (i). The field which intersects said incident light and perpendicular is made into datum level including the predetermined location by the side of the inner circumference of said disk (A). Make into origin of coordinates the point that said datum plane and said disk revolving shaft cross, and the value of the curvature in the scan location in the first round is disregarded for convenience the inner circumference side of said disk (A). Based on the information corresponding to the first round of said computer (j), the amount of displacement in the 2nd-round scan location is calculated. The amount of displacement in each scan location for which calculated the amount of displacement in the n+1st-round scan location, and it asked one after another by this sequence like the following based on the information corresponding to the n-th round by adding on the same radius The curvature measuring device of the disk characterized by finding the distance T (it being described as the amount T of curvatures below) from said datum level in the radius location and the angular position of said disk (A), and computing the camber angle of a circumferencial direction from the geometric relation based on said amount T of curvatures in each scan location.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the equipment and the approach of measuring the curvature of the circular disk which has the front face of light reflex nature, such as CD (compact disk), MO (magneto-optic disk), and DVD (a digital videodisc or digital versatile disc).
[0002]
[Description of the Prior Art] Conventionally, generally as a detection means of the camber angle of a disk, the location sensing element (it may be called PSD Position Sensitive Device and the following) is used. A laser beam is irradiated in the inspected side of a disk, and the technique of computing a camber angle by a location sensing element detecting the deflection of the reflective beam is well used for measurement of a camber angle. Moreover, as a general evaluation value of the camber angle of a disk, the camber angle of the two directions of radial and a circumferencial direction is used in many cases.
[0003]
[Problem(s) to be Solved by the Invention] When a single dimension (one direction) location sensing element was used for a location sensing element, though it was natural, only the camber angle of radial [of a disk] or the any 1 direction of a circumferencial direction could be measured, and the camber angle of two directions was not able to be measured to coincidence by one set of an one direction location sensing element.
[0004]
[Means for Solving the Problem] In measuring the curvature of the two directions of the circumferencial direction of a disk, and radial (two dimensions), when this invention persons inquire in view of the above-mentioned actual condition The place which examined wholeheartedly the approach of attaining it only using one set, in the single dimension location sensing element, Perform the complete scan of a disk and the radial camber angle of this disk in each scan location is detected. If the camber angle of the circumferencial direction of this disk in each scan location is computed based on the amount of curvatures which computed the amount of curvatures of this disk based on the detected radial camber angle, and was computed further Only it one set finds out that the camber angle of two directions can be measured to coincidence, and it came to complete this invention.
[0005] That is, this invention offers the following two invention, in order to solve the above-mentioned technical problem.
1. (element to constitute)
An exposure means to be the approach of measuring the curvature configuration of a circular disk (A) of having light reflex nature, and to irradiate laser light from a perpendicular direction continuously to the front face of said disk (A) (B), It has an one direction location detection means (C) based on the radial curvature of said disk (A) to detect the deflection from the specular reflection location of said reflected light. And the relative position of said exposure means (B) and said reflected light detection means (C) is being fixed. The means in which is the thing (a detection head (D) is called below) of integral construction, and either said detection head (D) or said disk (A) carries out a parallel displacement relatively [radial / of said disk (A)] (E), A means (F) to rotate said disk (A), and a means to read the rotation location of said disk (A) (G), A means to compound the signal from the location detection means (C) of said reflected light, and said rotation location reading means (G) (H), A means to extract the signal from said signal composition means (H) with a fixed time interval, and to record said extracted thing (I), Having the means (J) which carries out data processing of said recorded signal, and rotating said (how to operate a component) disk (A) with said rotation means (F) The spot which irradiated the front face of said disk (A) from said exposure means (B)

with said parallel displacement means (E) the signal showing location change of said reflected light resulting from the curvature of said disk (A) radial [at the time of making radial displaced relatively in respect of the light reflex of said disk (A)] -- and By compounding the signal showing the rotation location from a rotation location reading means (G) with said signal composition means (H), and calculating the signal which saved and saved the signal after composition for said signal record means (I) with said data-processing means (J) Are the measuring method which measures the curvature of said disk (A), and started record with said (the approach of data processing) signal record means (I). The field which intersects said incident light and perpendicular is made into datum level including the predetermined location by the side of the inner circumference of said disk (A). Make into origin of coordinates the point that said datum plane and said disk revolving shaft cross, and the value of the curvature in the scan location in the first round is disregarded for convenience the inner circumference side of said disk (A). It is based on the information corresponding to the first round of said output signal record means (J). Calculate the amount of displacement in the 2nd-round scan location, and it is based on the information corresponding to the n-th round like the following. The amount of displacement in each scan location for which calculated the amount of displacement in the n+1st-round scan location, and it asked one after another by this sequence by adding on the same radius The distance T (it is described as the amount T of curvatures below) from said datum level in the radius location and the angular position of said disk (A) is found. The curvature measuring method of the disk characterized by computing the camber angle of a circumferencial direction from the geometric relation based on said amount T of curvatures in each scan location (it is hereafter called the first invention.) .

[0006] 2. Semiconductor Laser Which is Equipment Which Measures Curvature Configuration of Circular Disk (A) of Having Light Reflex Nature, and Irradiates Laser Light from Perpendicular Direction Continuously to Front Face of Said Disk (A) (B), It has the single dimension location sensing element (c) which detects the deflection from the specular reflection location of said reflected light based on the radial curvature of said disk (A). And the relative position of said semiconductor laser (b) and said single dimension location sensing element (c) is being fixed. The 1 shaft movable slider in which is the thing [a detection head (d) is called hereafter] of integral construction, and either said detection head (d) or said disk (A) carries out a parallel displacement relatively [radial / of said disk (A)] (e), The rotation pulse generator which generates the rotation pulse signal which expresses the rotation location of said disk (A) as the motor (f) turning around said disk (A) (g), The signal composition circuit which compounds the signal from said single dimension location sensing element (c) and said rotation pulse generator (g) (h), The analog-to-digital converter which extracts the signal from said signal composition circuit (h) with a fixed time interval, and records said extracted thing (i), Having the computer (j) which carries out data processing of said recorded signal, and rotating said disk (A) by said motor (f) The spot which irradiated the front face of said disk (A) from said semiconductor laser (b) with said 1 shaft movable slider (e) the signal showing location change of said reflective beam resulting from the curvature of said disk (A) radial [at the time of making radial displaced relatively in respect of the light reflex of said disk (A)] -- and The signal showing the rotation location from said rotation pulse generator (g) is compounded by said signal composition circuit (h). Save the signal after composition at said analog-to-digital converter (i), and by calculating the saved signal by said computer (j) Are the measuring device which measures the curvature of said disk (A), and started record with said analog-to-digital converter (i). The field which intersects said incident light and perpendicular is made into datum level including the predetermined location by the side of the inner circumference of said disk (A). Make into origin of coordinates the point that said datum plane and said disk revolving shaft cross, and the value of the curvature in the scan location in the first round is disregarded for convenience the inner circumference side of said disk (A). Based on the information corresponding to the first round of said computer (j), the amount of displacement in the 2nd-round scan location is calculated. The amount of displacement in each scan location for which calculated the amount of displacement in the n+1st-round scan location, and it asked one after another by this sequence like the following based on the information corresponding to the n-th round by adding on the same radius The distance T (it is described as the amount T of curvatures below) from said datum level in the radius location and the angular position of said disk (A) is found. The curvature measuring device of the disk characterized by computing the camber angle of a circumferencial direction from the geometric relation based on said amount T of curvatures in each scan location (it is hereafter called the second invention.) .

[0007]

[Embodiment of the Invention] In enforcing the approach of the first invention of this invention, the equipment of the second invention can be used.

[0008] The approach and equipment of this invention consist of an element described above " constituted", "a method of operating a component", and "an approach of data processing."
[0009] The approach of this invention acquires the information about the radial curvature acquired above "the approach of operating a component", processes the information above "the approach of data processing", and makes it the information on the curvature of a circumferencial direction, and the greatest description is in the point of measuring both two directions of radial and a circumferencial direction to coincidence, using a single dimension location sensing element (single dimension PSD) one as "an element to constitute."
[0010] The circular disk (A) which has light reflex nature in this invention is ****************. The circular disk which consists of the synthetic-resin disk concerned which has the thin film of the metal concerned which may have the disk itself, such as the disk itself, such as aluminum which is the metal which reflects the laser light from an exposure means (B) to mention later, at high rate in this invention, copper, and gold, or a polycarbonate which is the synthetic resin which is a low rate and reflects laser light, and amorphous polyolefine, or the synthetic-resin thin film enveloping layer is used.
[0011] The compact disk with which metal vacuum evaporationo was given to the heat-resistant synthetic-resin disk which has a pit corresponding to information as this disk (A), for example and by which that metal vacuum evaporationo layer was covered by the hardening coat of ultraviolet-rays hardenability resin (CD), Metal vacuum evaporationo is given to the heat-resistant synthetic-resin disk which has a pit corresponding to information. The metal vacuum evaporationo layer The digital videodisc pasted up by the hardening coat of another heat-resistant synthetic-resin disk and ultraviolet-rays hardenability resin, A digital videodisc or a digital versatile disc (DVD) etc. which the metal vacuum evaporationo layer comrade of the disk of two sheets to whom metal vacuum evaporationo was given pasted up by the hardening coat of ultraviolet-rays hardenability resin is mentioned to the heat-resistant synthetic-resin disk which has a pit corresponding to information. Usual CD or usual DVD is about 1.2mm in thickness for the diameter of about 12cm.
[0012] Next, in carrying out this invention, each required means is explained. In this invention, the following eight means are indispensable.
** An exposure means to irradiate laser light (B)
** One direction location detection means (C)
** The means which carries out a parallel displacement relatively [radial / of said disk (A)] (E)
** A means to rotate said disk (A) (F)
** A means to read the rotation location of said disk (A) (G)
** A means to compound the signal from the location detection means (C) of said reflected light, and said rotation location reading means (G) (H)
** A means to extract and record the signal from said signal composition means (H) (I)
** The means which carries out data processing of the recorded signal (J)
[0013] Although the exposure means of the well-known common use which can irradiate a laser beam continuously can be adopted as an exposure means (B), semiconductor laser (b) is mentioned, for example. Although you may hit against a non-irradiating object as it is, laser light is usually thinly extracted with a floodlighting lens, and after considering as a beam, it is used. The exposure means is installed in the location which can irradiate laser light from a perpendicular direction to the front face of a disk (A). The irradiated laser light forms an optical spot in a disk (A) front face. In addition, when the curvature of a disk (A) is zero, it becomes the same as that of the direction of a laser light reflex perpendicularly to a disk front face.
[0014] An one direction location detection means (C) catches that the light irradiated at right angles to the front face of the disk (A) of the curvature measuring object turns into the reflected light, and returns, and asks for the variation rate of the reflected light in the point of measurement chosen as a disk (A) front face by arbitration. A means (C) is formed in the location which can receive the reflected light, and detects the deflection from the specular reflection location of the reflected light. If it is completely specular reflection, a variation rate is zero, but if curvature is in the point of measurement of a disk (A), it will serve as a variation rate and will appear. As a means (C), although each thing of well-known common use can use it, a single dimension location sensing element (c) typical as a location sensing element (Position Sensitive Device) is used.
[0015] In thing [this invention which the relative position of said exposure means (B) and an one direction location detection means is being fixed, and became integral construction in this invention, this integral-construction object is called a detection head (D).] It enables it to have detected ******** and the variation rate based on the deflection from a specular reflection location certainly.

[0016] Although the relative position of an exposure means (B) and a detection means (C) is not restricted if the reflected light enables it to receive light certainly, it can form an optical-path modification means (K) in the optical path of the reflected light, and can make uniformly what what has a deflection from a specular reflection location does not have in the reflected light based on exposure light it in another direction in false, for example. As a means (K), the beam splitter (k) represented by the half mirror, for example can be used.
[0017] It is more desirable to irradiate continuously and to detect the deflection from the specular reflection location in the point of measurement of the disk (A) to need, although laser light irradiates the rotating disk (A) intermittently and you may make it detect the deflection from the specular reflection location in the point of measurement of a disk (A).
[0018] Although ********** [the number of point of measurement / what], it is desirable to establish 50-10,000 points towards a part for the outermost periphery from the most-inner-circumference part of the light reflex side front face of a disk (A). And it is desirable to set up point of measurement on at least one radius from which the locus which contracted each [these] point of measurement serves as a continuous curled form, and is chosen as arbitration, so that each point of measurement may be located in a line.
[0019] As for the means (E) which carries out a parallel displacement relatively [radial / of a disk (A)], the following two things are contained. That is, said detection head (D) does not move, but the rotating disk (A) is the means for which the laser light from an exposure means (B) is irradiated by radial [the] and which can move now like contrary to the means which the above-mentioned disk (A) does not move only by rotating, but the above-mentioned detection head (D) can move now to radial [of the rotating disk], and it.
[0020] As this means (E), a 1 shaft movable slider (e) can be used, for example. As this slider (e), each of things it was made to move by pneumatic pressure to a precision, and things made electric can use it. Like, in order [above-mentioned] to make it move to radial [of a disk (A)], a detection head (D) What is necessary is to fix to this means (E) and just to make it move at the time of measurement, and it on the contrary, a disk (A) -- radial [of a disk (A)] -- and what is necessary is to fix to this means (E) and just to use a disk rotation means (F) to mention later, like, in order [whose exposure light from an exposure means (B) hits radial] to make it move
[0021] Although each thing whose rotation nonuniformity cannot be found as much as possible and which can always rotate a disk with a fixed rotational speed can adopt like as a means (F) to rotate a disk (A), a motor (f) is usually used. Moreover, a disk (A) does not idle on a means (F), but it is usually fixed at the time of measurement so that it may rotate synchronizing with rotation of a motor. The power transfer section of a means (F) can be made to rotate a disk (A) by non-contact type MAG coupling using the magnetic attraction in order to prevent that vibration of the source of power is transmitted to a disk (A).
[0022] Moreover, in order for a rotation location reading means (G) to mention later to detect the rotation location of a disk (A), a projection parallel to radial [of a disk (A)] or a disk with a slit is fixed to a means (F), and it is prepared. This projection or the disk with a slit is prepared so that it may become parallel to a virtual radius including the point of measurement and point of measurement of the beginning of a disk (A). This projection or the disk with a slit is ****(ed) with a means (G), and the role which specifies the absolute rotation location on a disk (A) is played.
[0023] As a rotation location reading means (G), although each thing of well-known common use can use it, the rotation pulse generator which generates the rotation pulse signal showing the rotation location of said disk (A) (g), for example, a photo interrupter, a rotary encoder, etc. can be used. A photo interrupter has a light-emitting part and a light sensing portion, it is with the case where it does not exist with the case where an obstruction exists between them, and a difference produces it on the output-signal level. If it is made to use combining the projection or the disk with a slit fixed to the photo interrupter and the above-mentioned rotation means (F), the absolute location under rotation of the disk (A) fixed to the means (F) can be decided with the signal level. Moreover, without using the combination of the projection or the disk with a slit fixed to the above-mentioned rotation means (F), and a photo interrupter as a rotation location reading means (G), when a rotary encoder is used, the rotation pulse signal of a disk is directly obtained from a means (F), and can decide the absolute location under rotation of a disk (A) with the signal level.
[0024] As a means (H) to compound the signal from said means (C) and said means (G), the circuit [**** / well-known] (h) which has such a function can be used. To a synthetic means (H), the signal which shows the reflective location change resulting from radial curvature for every point of measurement, and the signal showing the rotation location from a means (G) are sent, and they are compounded. Thereby, the positional information of point of measurement and the information on reflective location change can be made to correspond by one to one.
[0025] Thus, the information which corresponded by one to one is sent to a record means (I) next. The

signal from said signal composition means (H) is extracted with a fixed time interval, and an analog-to-digital converter (i) can be used as a means (I) to record said extracted thing.
[0026] The information saved for the above-mentioned means (I) is sent, and after the amount of curvatures of a circumferencial direction is calculated based on the signal showing the rotation location from the signal and means (G) which show the reflective location change resulting from the radial curvature for every point of measurement, the camber angle of a circumferencial direction is computed by the data-processing means (J) there. As this means (J), a computer (j) is usually used.
[0027] Thus, it is more desirable to indicate by visual together with a radial camber angle, and to usually display extent of curvature visually, although you may make it grasp each camber angle of the circumferencial direction in each point of measurement of the disk (A) obtained with the means (J) as numerical information as it is. In this case, in three dimensions, image display is carried out to a display, or it can print on paper, a film, etc.
[0028] Next, an example of the curvature measuring device of the disk concerning this invention which can enforce the approach of above-mentioned this invention is explained more to a detail with reference to drawing 1 .
[0029] The optical-path modification means (K) is installed on the beam-of-light optical path a from a laser Mitsuteru gunner stage (B), and a disk rotation means (F) to make said optical path a and a disk (A) cross at right angles, and to support it is established on the production. In the location of a means (K), an one direction location detection means (C) to detect the deflection of light based on the radial curvature of a disk is installed in the direction [the direction in which the reflected ray from a disk (A) is reflected by the means (K)] which intersects perpendicularly with an optical path a. And laser light forms an optical spot here in the condition that extract with the floodlighting lens which is not illustrated, hit a disk (A) as a beam, and the disk (A) is not rotating.
[0030] The signal composition means (H) is electrically connected to the latter part of a location detection means (C). The laser Mitsuteru gunner (stage B) one direction location detection means (C) and the optical-path modification means (K) are supported by the parallel displacement means (E) in one.
[0031] A rotation location reading means (G) approaches a disk rotation means (F), and is installed, and the output section of a rotation location reading means (G) is electrically connected to the input section of a signal composition means (H). A signal record means (I) is connected to the latter part of a signal composition means (H), and the data-processing means (J) is further connected to the latter part of a signal record means (I) electrically, respectively.
[0032] Next, the operation of the curvature measuring device of the disk of said configuration is explained with reference to drawing 7 from drawing 1 .
[0033] In drawing 1 , laser light is first irradiated on an optical path a from a laser Mitsuteru gunner stage (B). The irradiated laser light passes an optical-path modification means (K), and is irradiated by the disk (A) from a direction perpendicular to a disk (A). The reflected light from a disk (A) which has light reflex nature passes along an optical path b, and incidence is carried out to an one direction light-receiving location detection means (C) through an optical-path modification means (K). That is, only exposure light goes straight on and an optical path is changed only for the reflected light.
[0034] A disk (A) rotates to a circumferencial direction with a disk rotation means (F), and it is in the condition of the pair-ized detection head (D), and with a parallel-translation means (E), the laser Mitsuteru gunner (stage B) one direction location detection means (C) and an optical-path modification means (K) can be united, maintaining relative physical relationship, and can move it now only to radial [of a disk (A)].
[0035] Laser light serves as a spot, is illuminated on a disk (A) by said rotation actuation and migration actuation, and can scan now the whole surface of a disk light reflex side continuously to a curled form by them.
[0036] And a detection head (D) is turned to a periphery side from the inner circumference side of a disk light reflex side, rotating a disk (A) with a means (F), and it can measure, making it move by radial.
[0037] During said complete scan, when there is no curvature in the disk side of a scan location, incidence of the laser beam which scanned the disk (A) as shown in drawing 2 is carried out to the light sensing portion mid gear of an one direction location detection means (C), and the electrical signal of a zero level is outputted to the output terminal 1 of an one direction location detection means (C).
[0038] On the other hand, curvature is in the disk side of a scan location, and it is an include angle to a datum plane c. When only r leans, from an optical path a, only include-angle 2thetar shifts, it reflects, and incidence of the laser beam which scanned the disk (A) as shown in drawing 3 R> 3 is carried out to the light sensing portion of an one direction location detection means (C).

[0039] If distance from the light sensing portion mid gear of an one direction location detection means (C) to a laser-beam incidence location is set to delta at this time, the electrical signal proportional to distance delta will be outputted to the output terminal 1 of an one direction light-receiving location detection means (C). Moreover, since relation between curvature include-angle 2thetar generally used as an evaluation value and distance delta as shown in a formula 1 is from easy geometric consideration at this time, it can ask for camber-angle 2thetar by measuring the electric-generating-power signal level of an one direction location detection means (C).

[0040]

[Formula 1]

2thetar=arctan {delta/LA+LB} --- Formula 1 [0041] Drawing 4 is a timing chart showing actuation of a signal composition means (H). From an one direction location detection means (C), the signal 1 corresponding to the radial camber angle of the disk in a scan location is outputted. From a rotation location reading means (G), the signal 2 which produces a rectangular pulse (a rotation pulse is called hereafter) for every rotation of a disk (A) is outputted.

[0042] The one direction location detection means output signal 1 and the rotation location reading means output signal 2 are compounded by the signal composition means (H), as shown in drawing 4 (c), and they turn into an output signal 3. Record-keeping of this signal composition means output signal 3 is extracted and carried out with a fixed time interval by the signal record means (I).

[0043] The thing of the device with which an analog-to-digital converter and electronic memory were united can be used for a signal record means (I). The information by which record-keeping was carried out to said signal record means (I) is transported to an operation means (J) like a computer.

[0044] The transported signaling information is separated into a rotation pulse and the information on curvature by the threshold set up beforehand, and the check of the information number is performed for every rotation about the information on curvature. Since the time interval of information record is fixed, when the rotational speed of a disk is fixed, the information number for every rotation becomes fixed.

[0045] On the other hand, when the rotational speed of a disk has fluctuation, although only a rotational changed part fluctuates the information number for every rotation, it is considered that the minimum information number is the information number (it is described as the criteria information number below) of criteria. In each rotation, since required geometric calculation is simplified in the case of calculation of the amount of curvatures of the below-mentioned disk, and a circumferencial direction camber angle, the curvature information more than the criteria information number can be deleted.

[0046] Without integrating a gap of the scan location by rotational fluctuation by all rotations, and making it into a big measurement error, this processing of a single string of "compounding a rotation pulse with the information signal of curvature, and re-dissociating" is processed within the limits of the small gap for every rotation, and has the effectiveness of making a measurement error absorb within the limits of one rotation.

[0047] Drawing 5 shows the locus on which a laser beam scans a disk front-face top. The locus of a scan becomes spiral, and if the number of rotations which takes the criteria information number per disk 1 rotation for I and a laser beam to scan the whole disk surface is set to N, the temporary storage of the data of the curvature information on an IxN individual will be carried out to the memory of an operation means (J) per disk of one sheet. If 1, 2, 3, ..., N, and a number are attached to the locus of a curled form scan from the inside, it will correspond to the location where the starting point of the curled form locus 1 carried out extract initiation of the information from an one direction location detection means (C), and the terminal point of the curled form locus 1 will turn into the starting point of the curled form locus 2.

[0048] Although the extract of data is performed by the equiangular distance to a disk center position in each locus, it is made the extracted data from the starting point side of each locus at ****** which attaches 1, 2, 3, ..., I, and a number. Moreover, the radial pitch of a curled form locus is set to p.

[0049] In the curvature information data of an IxN individual, if the value acquired in the i-th location on the curled form locus n is expressed as Xni (however, n= 1, 2, ..., N and i= 1, 2, ..., I), it can be considered that X1i, X2i, ..., Xni, ..., XNi are data mostly extracted on the same radius.

[0050] And when the value of the curvature in said curled form locus 1 is disregarded for convenience and it considers that the field inside said locus 1 is a flat surface, the value (it is described as S2i for convenience) of the curvature in the location of i on the curled form locus 2 is expressed like the next in primary approximation using X1i.

[0051]

[Formula 2]

S2i = pxsinthetar 2i --- Formula 2 [0052]

[Formula 3]
thetar2i=(1/2) xarctan {X2i/(LA+LB)} --- Formula 3 [0053] Here, the reason for is concluded as it being the range where the effect which the value of the curvature in "curled form locus 1 is disregarded for convenience, and this assumption brings the field inside said locus 1 the bottom wholly as a flat surface hardly becomes a problem practically. By the actual disk, in almost all cases, distortion and deformation are missing from the periphery side of a disk, and become large, and said assumption can be set up that it is comparatively small in an inner circumference side, and by that the absolute value of disk deformation itself is becoming small, and a disk manufacturing technology's improving every year and saying.

[0054] More generally what changed the suffix 2 of a formula 2 and a formula 3 into n can express the amount Sni of displacement in the i-th location on the curled form locus n+1 which the next adjoins on the basis of the location with the value of Xni obtained in the location of the i-th arbitration on the curled form locus n of arbitration.

[0055] If the field which intersects said incident beam and perpendicular including the predetermined location by the side of the inner circumference of the disk (A) which started record, i.e., the location where data X11 was extracted, with a signal record means (H) is made into datum level, the amount Tni (namely, the amount of curvatures) of displacement from said datum level in an arbitration point will be calculated like the degree type 4.

[0056]
[Formula 4]

$$T_{ni}=\sum_{j=1}^{n} S_{ji} \qquad --- \text{式}4$$

[0057] The amount of curvatures in each point of a complete scan becomes settled by the formula 4, and the camber angle of the circumferencial direction in each scanning point is computed based on this amount of curvatures.

[0058] Next, the procedure is explained. Drawing 6 shows the technique of calculating a circumferencial direction camber angle from the amount of curvatures in each scanning point of a disk.

[0059] If distance from the scanning point i on alpha and the curled form locus n to the disk central point is set to rni for the include angle at which a disk rotates the distance from a scan start point (n= 1, i= 1) to a disk core during r0 and the adjoining scanning point, section deltaLni from the scanning point i to the scanning point i+1 will be calculated for i like [consideration / geometric] the degree type 5.

[0060]
[Formula 5]
deltaLni=2pixrnix (alpha/360) --- Formula 5 [0061]
[Formula 6]
rni=r0+px (n-1+i/I) --- Formula 6 [0062] In addition, since there are many scanning points per disk 1 rotation, and the pitch p of a curled form locus approximated deltaLni with radii when small enough compared with rni although deltaLni was a part of curled form locus n, the formula 5 was drawn.

[0063] Drawing 7 looks at drawing 6 -b from the direction of Direction M. Camber-angle 2 tni of the circumferencial direction more generally than this drawing used as an evaluation value is calculated like the degree type 7 from geometric consideration.

[0064]
[Formula 7]
2thetatni=2xarctan (Tn(i+1)-Tni) (/deltaLni) --- Formula 7 [0065] Based on the amount of curvatures of this disk that detected the radial camber angle of each scan location on a disk as mentioned above, computed the amount of curvatures of this disk based on the detected radial camber angle, and was computed further, the camber angle of the circumferencial direction in each scan location is computable. That is, it becomes possible to detect one camber angle of the two directions of a circumferencial direction and radial using the location sensing element of an one direction.

[0066] This invention includes the next invention.

1. Exposure Means to be Approach of Measuring Curvature Configuration of Circular Disk (A) of Having Light Reflex Nature, and to Irradiate Laser Light from Perpendicular Direction Continuously to Front Face of Said Disk (A) (B), It has an one direction location detection means (C) based on the radial curvature of said disk (A) to detect the deflection from the specular reflection location of said reflected light. And the relative position of said exposure means (B) and said reflected light detection means (C) is being fixed. The

means in which is the thing (a detection head (D) is called below) of integral construction, and either said detection head (D) or said disk (A) carries out a parallel displacement relatively [radial / of said disk (A)] (E), A means (F) to rotate said disk (A), and a means to read the rotation location of said disk (A) (G), A means to compound the signal from the location detection means (C) of said reflective beam, and said rotation location reading means (G) (H), A means to extract the signal from said signal composition means (H) with a fixed time interval, and to record said extracted thing (I), The spot which irradiated the front face of said disk (A) from said exposure means (B), having the means (J) which carries out data processing of said recorded signal, and rotating said disk (A) with said rotation means (F) with said parallel displacement means (E) the signal showing location change of said reflected light resulting from the curvature of said disk (A) radial [at the time of making radial displaced relatively in respect of the light reflex of said disk (A)] -- and By compounding the signal showing the rotation location from a rotation location reading means (G) with said signal composition means (H), and calculating the signal which saved and saved the signal after composition for said signal record means (I) with said data-processing means (J) Are the measuring method which measures the curvature of said disk (A), and started record with said signal record means (I). The field which intersects said incident light and perpendicular is made into datum level including the predetermined location by the side of the inner circumference of said disk (A). Make into origin of coordinates the point that said datum plane and said disk revolving shaft cross, and the value of the curvature in the scan location in the first round is disregarded for convenience the inner circumference side of said disk (A). It is based on the information corresponding to the first round of said output signal record means (J). Calculate the amount of displacement in the 2nd-round scan location, and it is based on the information corresponding to the n-th round like the following. The amount of displacement in each scan location for which calculated the amount of displacement in the n+1st-round scan location, and it asked one after another by this sequence by adding on the same radius The curvature measuring method of the disk characterized by finding the distance T (it being described as the amount T of curvatures below) from said datum level in the radius location and the angular position of said disk (A), and computing the camber angle of a circumferencial direction from the geometric relation based on said amount T of curvatures in each scan location.

[0067] 2. On Exposure Optical Path of Means (B), Exposure Light Can Irradiate so that it May Go Straight on at Right Angles to Front Face with Optical Reflexibility Side of Disk (A). The approach of one above-mentioned publication using what established the optical-path modification means (K) which changes a direction and enables it to receive only the reflected light for a means (C), was fixed, respectively while the means (B), the means (C), and the means (K) had maintained the relative position so that said function might be achieved, and became integral construction.

[0068] 3. Approach of one above-mentioned publication of asking for disk rotation location, using optical reading means as reading means (G).

[0069] 4. Semiconductor Laser Which is Equipment Which Measures Curvature Configuration of Circular Disk (A) of Having Light Reflex Nature, and Irradiates Laser Light from Perpendicular Direction Continuously to Front Face of Said Disk (A) (B), It has the single dimension location sensing element (c) which detects the deflection from the specular reflection location of said reflected light based on the radial curvature of said disk (A). And the relative position of said semiconductor laser (b) and said single dimension location sensing element (c) is being fixed. The 1 shaft movable slider in which is the thing [a detection head (d) is called hereafter] of integral construction, and either said detection head (d) or said disk (A) carries out a parallel displacement relatively [radial / of said disk (A)] (e), The rotation signal generator which generates the rotation pulse signal which expresses the rotation location of said disk (A) as the motor (f) turning around said disk (A) (g), The signal composition circuit which compounds the signal from said single dimension location sensing element (c) and said rotation signal generator (g) (h), The analog-to-digital converter which extracts the signal from said signal composition circuit (h) with a fixed time interval, and records said extracted thing (i), Having the computer (j) which carries out data processing of said recorded signal, and rotating said disk (A) by said motor (f) The spot which irradiated the front face of said disk (A) from said semiconductor laser (b) with said 1 shaft movable slider (e) the signal showing location change of said reflected light resulting from the curvature of said disk (A) radial [at the time of making radial displaced relatively in respect of the light reflex of said disk (A)] -- and The signal showing the rotation location from said rotation signal generator (g) is compounded by said signal composition circuit (h). Save the signal after composition at said analog-to-digital converter (i), and by calculating the saved signal by said computer (j) Are the measuring device which measures the curvature of said disk (A), and started record with said analog-to-digital converter (i). The field which intersects said incident light and perpendicular is made into datum level including the predetermined location by the side of the inner circumference of said disk (A). Make into origin of coordinates the point that said datum plane and said disk revolving shaft cross, and the value of the curvature in the scan location in the first round is disregarded for convenience the inner circumference side of said disk (A). Based on the information corresponding to the first round of said computer (j), the amount of displacement in the 2nd-round scan location is calculated. The amount of displacement in each scan location for which calculated the amount of displacement in the n+1st-round scan location, and it asked one after another by this sequence like the following based on the information corresponding to the n-th round by adding on the same radius The curvature measuring device of the disk characterized by finding the distance T (it being described as the amount T of curvatures below) from said datum level in the radius location and the angular position of said disk (A), and computing the camber angle of a circumferencial direction from the geometric relation based on said amount T of curvatures in each scan location.

[0070] On Exposure Optical Path of Semiconductor Laser (B), 5. Exposure Light It can irradiate so that it may go straight on at right angles to a front face with the optical reflexibility side of a disk (A). The beam splitter (k) which changes a direction and enables it to receive only the reflected light for a component (c) is prepared. Equipment of four above-mentioned publication using what was fixed, respectively and became integral construction while semiconductor laser (b), the single dimension location sensing element (c), and the beam splitter (k) had maintained the relative position so that said function might be achieved.

[0071] 6. Equipment of four above-mentioned publication which asked for the disk rotation location using the photo interrupter (g), using the fixed motor which becomes parallel to radial [surface] at a disk about the projection or the disk with a slit rotated as a motor (f) synchronizing with a disk.

7. Equipment of four above-mentioned publication which uses combining a motor (f) and a rotary encoder and asked for the disk rotation location.

On Exposure Optical Path of Semiconductor Laser (B), 8. Exposure Light It can irradiate so that it may go straight on at right angles to a front face with the optical reflexibility side of a disk (A). The beam splitter (k) which changes a direction and enables it to receive only the reflected light for a component (c) is prepared. Semiconductor laser (b), the single dimension location sensing element (c), and the beam splitter (k) have maintained the relative position so that said function may be achieved. What was fixed, respectively and became integral construction is used. As a motor (f) Equipment of four above-mentioned publication which asked for the disk rotation location using the photo interrupter (g), using the fixed motor which becomes parallel to radial [surface] at a disk about the projection which carries out rotation ** synchronizing with a disk.

On Exposure Optical Path of Semiconductor Laser (B), 9. Exposure Light It can irradiate so that it may go straight on at right angles to a front face with the optical reflexibility side of a disk (A). The beam splitter (k) which changes a direction and enables it to receive only the reflected light for a component (c) is prepared. Semiconductor laser (b), the single dimension location sensing element (c), and the beam splitter (k) have maintained the relative position so that said function may be achieved. Equipment of four above-mentioned publication which uses combining a motor (f) and a rotary encoder and asked for the disk rotation location, using what was fixed, respectively and became integral construction.

[0072]

[Example] Hereafter, although this invention is further explained to a detail using an example, this invention is not limited to these examples. As an example, the thing equivalent to the above-mentioned operation gestalt 8 was mentioned.

[0073] The camber angle of DVD (Digital Video Disc) was measured using the equipment of the structure shown in drawing 8 . The outer diameter of DVD11 which is a device under test is 120mm, among those measured over the range of 48mm - 116mm diameter (light reflex side).

[0074] It was made at least for a single dimension to make PSD (Position Sensitive Device)13 detect the deflection (location) of the laser beam reflected light based on the radial curvature of DVD11 as a laser Mitsuteru gunner stage using the semiconductor laser 12 made into the wavelength of 670nm, and the beam diameter of about 1mm.

[0075] Moreover, it takes out with the height and photo interrupter 15 which are made to rotate DVD by per second 12 rotation, ** the rotation information said with a motor, and rotate, using AC servo motor 14 as a DVD rotation means, the rotation pulse signal 2 is generated, and it was made to make this signal input into the signal composition circuit 16.

[0076] The detection head 18 was turned to the periphery side, and the migration means of the detection head 18 was made to move it to the disk radial from an inner circumference side at the rate of per second

12.75mm using the 1 shaft electric slider 17. At this time, laser-beam scanning pitch p on DVD was about 1.06mm, and the rotational frequencies which the complete scan of DVD takes were 32 rotations.

[0077] The signal 1 including the information on the curvature outputted from a single dimension PSD13 at the time of a scan was inputted into the rotation pulse signal 2 and coincidence in the signal composition circuit 16, as both signals are shown in drawing 4 (c), after compounding, the analog-to-digital (A/D) converter 19 extracted the composite signal 3 with the time interval for 833x 10 to 6 seconds (sampling frequency of 1.2kHz), and the extracted data were stored in the memory of a computer 20.

[0078] A computer 20 performs amendment processing of a disk rotation fluctuation component, and data processing based on a formula 2 - a formula 7, and it was made to make each characteristic value compute to said storing data, in order of the radial camber angle of each scan location on a disk, the amount of curvatures of a disk, and a circumferencial direction camber angle finally, as mentioned above in the usage of a curvature measuring device.

[0079] The approach of this invention understands also from the following thing that it is the effective approach very much in curvature measurement.

[0080] Drawing 9 , It is the scatter diagram showing the correlation of the calculated value of the circumferencial direction camber angle of DVD and the actual measurement in an example. Calculated value detects a radial camber angle using a single dimension location sensing element as mentioned above, and it asks for a circumferencial direction camber angle by count, and on the other hand, an actual measurement changes arrangement of a single dimension location sensing element 90 degrees centering on a laser-beam optical axis, and it is made to make the deflection of a laser beam based on the circumferencial direction curvature of a disk detect, and it asks for a circumferencial direction camber angle like the case of a radial camber angle.

[0081] In this drawing, an axis of abscissa is an actual measurement, and an axis of ordinate is calculated value, and the number of the scanning points is about 3200 points. A correlation coefficient is 0.91 and it turns out that calculated value and an actual measurement correspond well. The point which is recognizing a large number existence so that it may stick near the axis of abscissa is considered to be the effect of assumption the above-mentioned "considers [the value of the curvature in the curled form locus 1 is disregarded for convenience, and] that the field inside said locus 1 is a flat surface."

[0082] Since the camber angle assumed calculated value to be zero to the scanning point which is not zero with the actual measurement, n of the curled form locus 1 and the curled form locus n becomes easy to generate an abnormality point near the axis of abscissa, when low.

[0083] Drawing 10 is the scatter diagram which deleted the point of the most inner circumference which is the first portion among the scanning points of drawing 9 - a center (it is henceforth expressed as 1/2 scan), and left only the scanning point of the 1/2 scan which is the section in the second half - the outermost periphery. Thus, the maximum (the forward direction 152 [mdeg], hard flow 178 [mdeg]) of a camber angle can decrease the abnormality point near the axis of abscissa as it is by deleting the scanning point by the side of disk inner circumference. PSD calculated value and an actual measurement come to correspond still better, and the correlation coefficient of drawing 10 goes up to 0.96.

[0084] The scatter diagram where drawing 11 left only the scanning point of 3/4 scan - the outermost periphery among the scanning points of drawing 9 , and drawing 12 are the scatter diagrams which left only the scanning point of 7/8 scan - the outermost periphery like drawing 10 . Even if it deletes the scanning point this much, the maximum of a camber angle does not change. Thus, it can be said that this approach and equipment with the description whose precision improves rapidly have sufficient practicality about measurement of the camber-angle maximum of a disk as a scan is on a periphery side, since the maximum of a camber angle exists in the part of the periphery approach of a disk chiefly.

[0085]

[Effect of the Invention] Since it asks for one camber angle of a circumferencial direction from the information on radial curvature using an one direction location detection means (or component) according to the curvature measuring method and curvature measuring device of a disk of this invention as explained above, the effectiveness that the camber angle of the two directions of radial and a circumferencial direction can be measured to coincidence is done so by one actuation.

[Translation done.]

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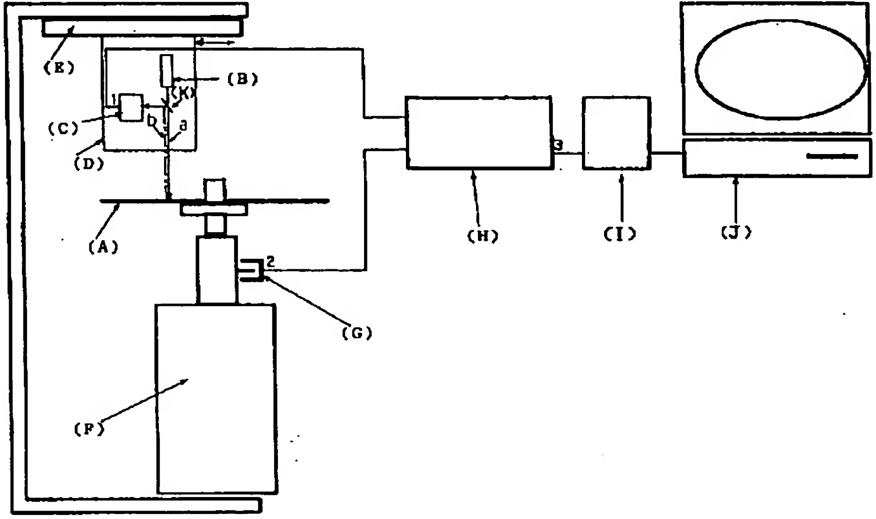
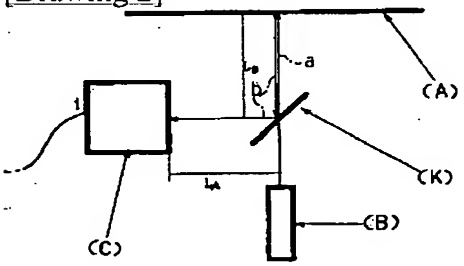
DRAWINGS

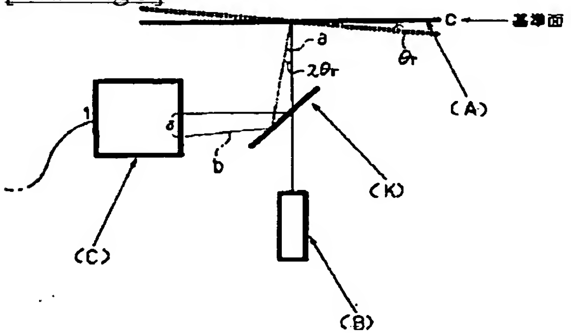
[Drawing 1]


(E)
(B)
(K)
1
(C)
b
a
(D)
(A)
2
(G)
(F)
3
(H)
(I)
(J)

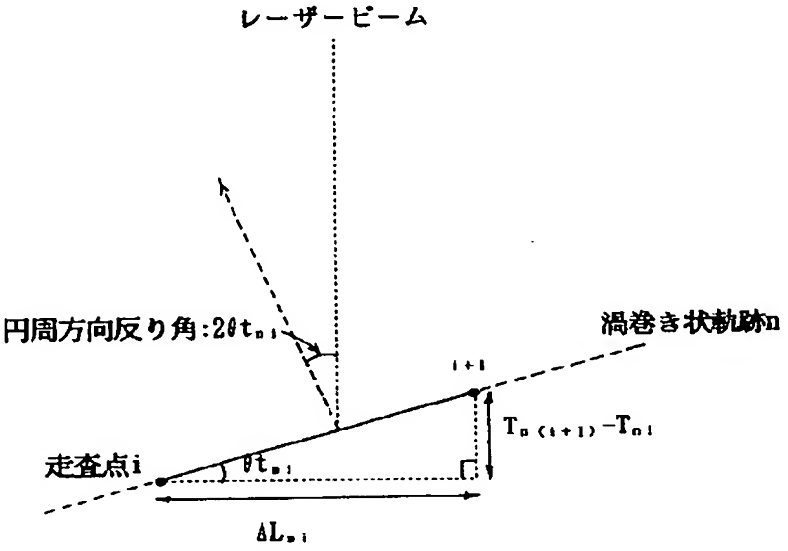
[Drawing 2]



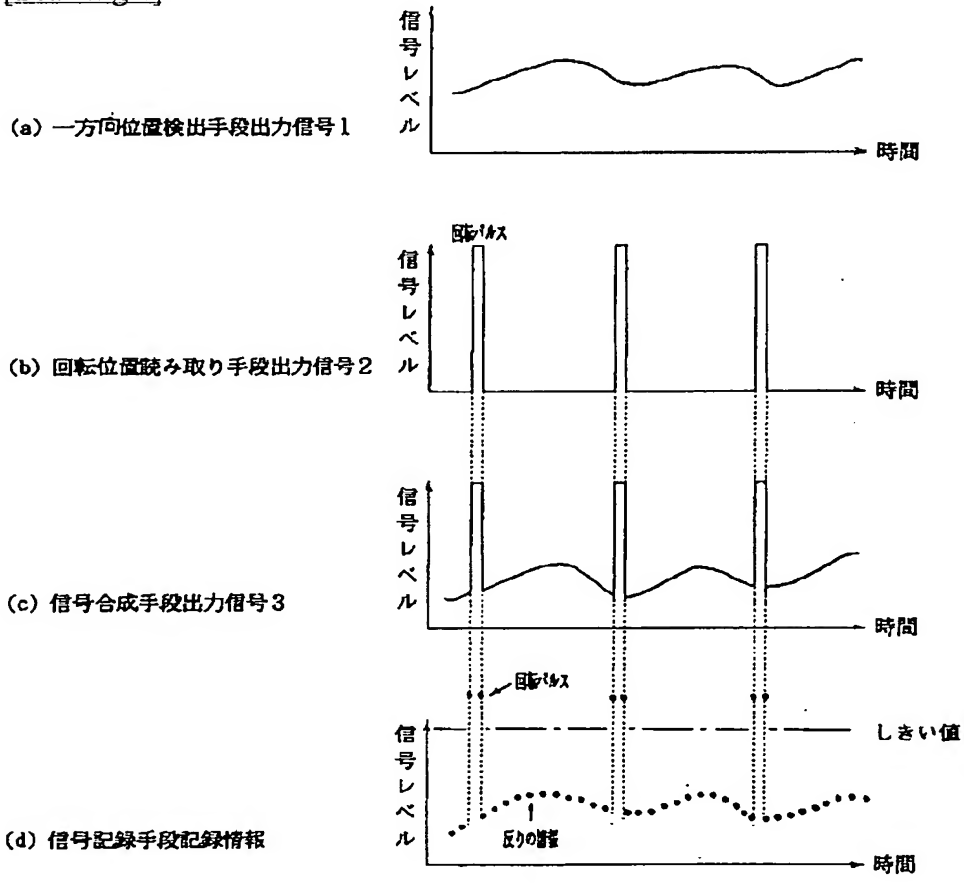
[Drawing 3]


C
基準面
a
2θr
θr
(A)
1
δ
b
(K)
(C)
(B)

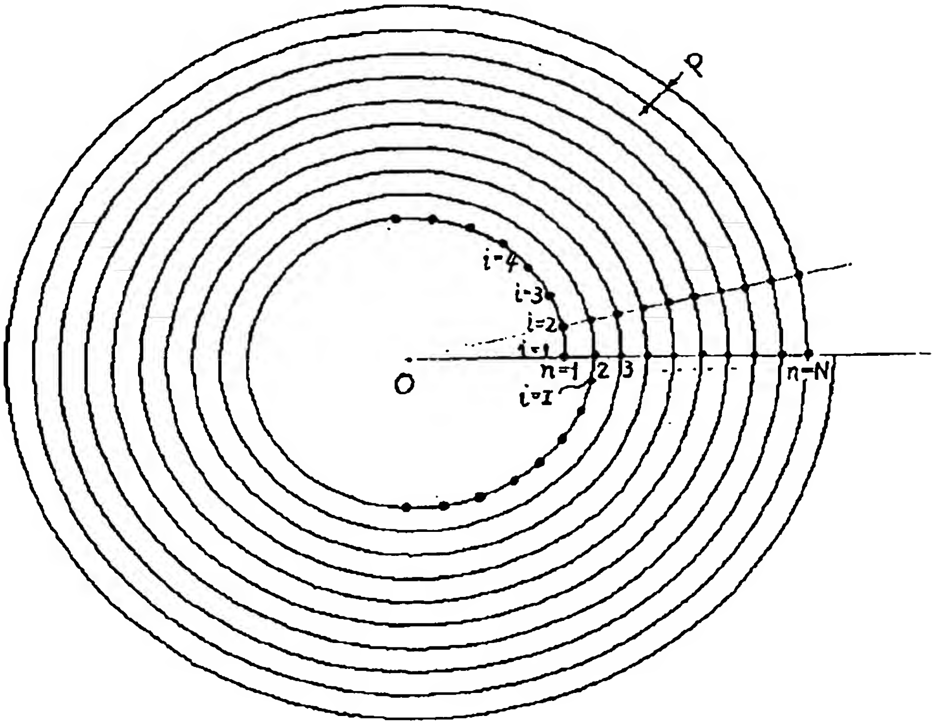
[Drawing 7]


レーザービーム
円周方向反り角:2θt_ni
渦巻き状軌跡n
i+1
T_n(i+1)−T_ni
走査点i
θt_ni
ΔL_ni

[Drawing 4]

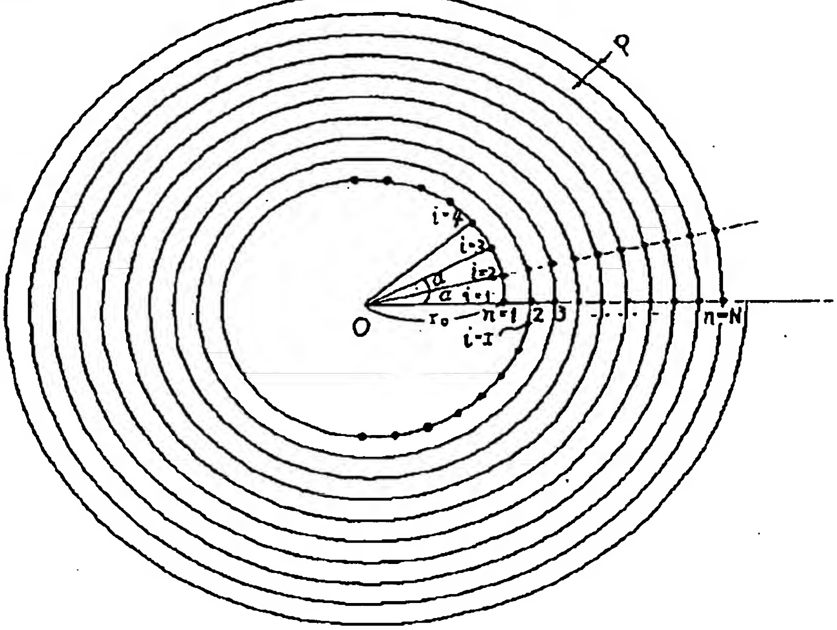


[Drawing 5]


P
i=4
i=3
i=2
i=1
O
n=1
2
3
n=N
i=I

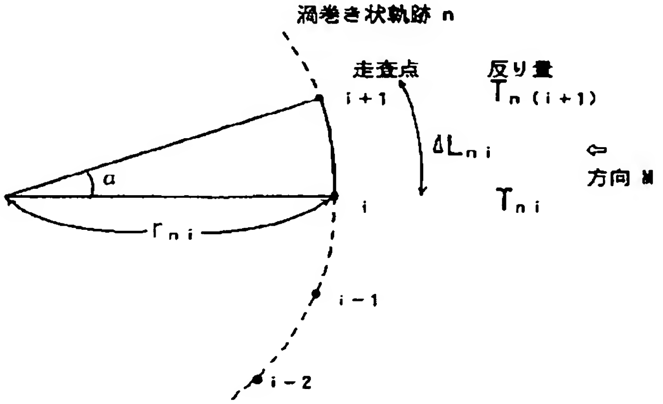
[Drawing 6]

図6－a

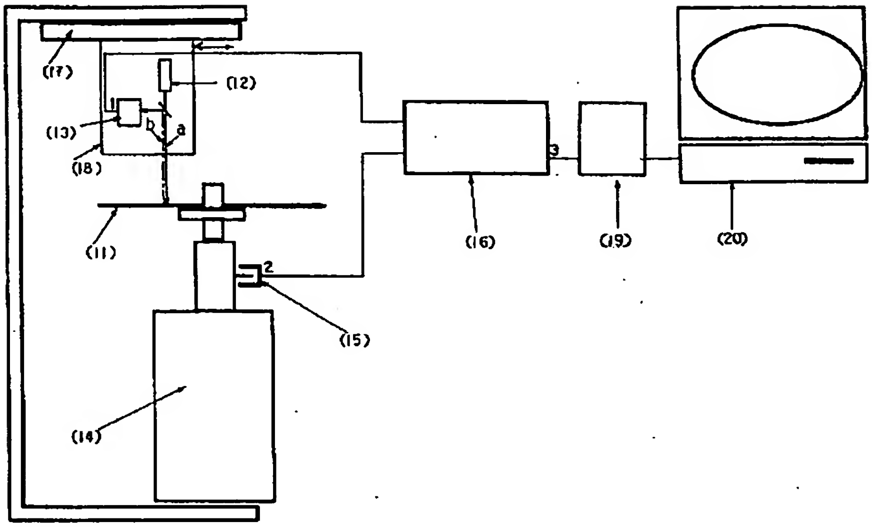

Q
i=4
i=3
i=2
i=1
α
α
O
r₀
n=1
2
3
n=N
i=I

⇩ 〔渦巻き状軌跡n上のi番目及びi+1番目の走査点により規定される扇状領域〕

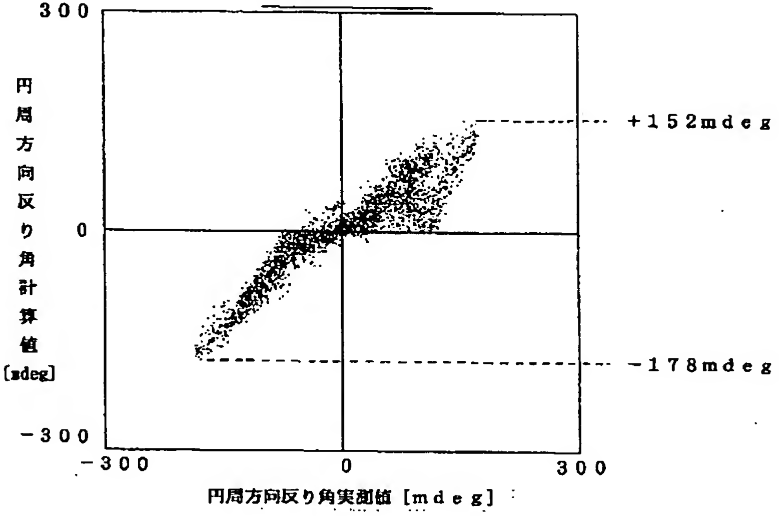
図6－b


渦巻き状軌跡 n
走査点
反り量
i+1
Tn (i+1)
ΔLn i
⇦
方向 M
α
Tn i
rn i
i
i－1
i－2

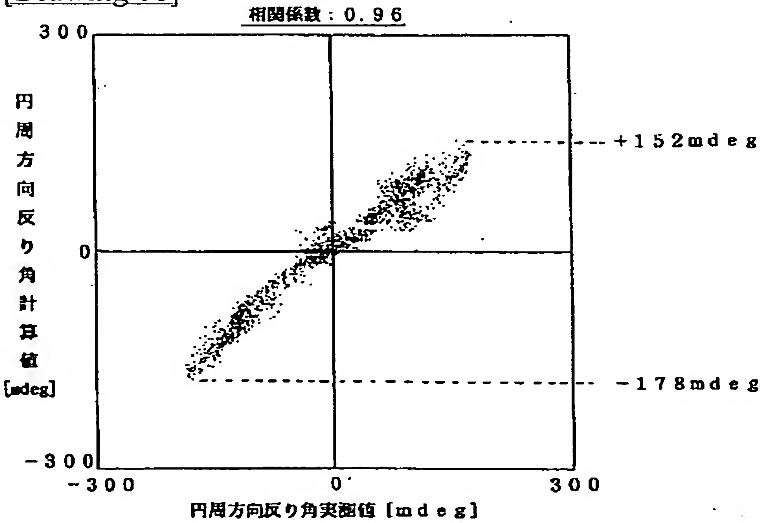
[Drawing 8]


(17)
(12)
(13)
b
a
(18)
(11)
(16)
3
(19)
(20)
2
(15)
(14)

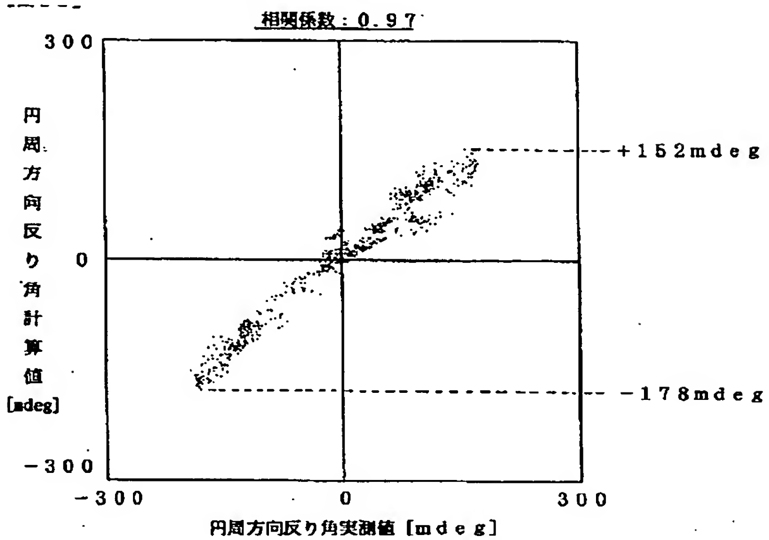
[Drawing 9]



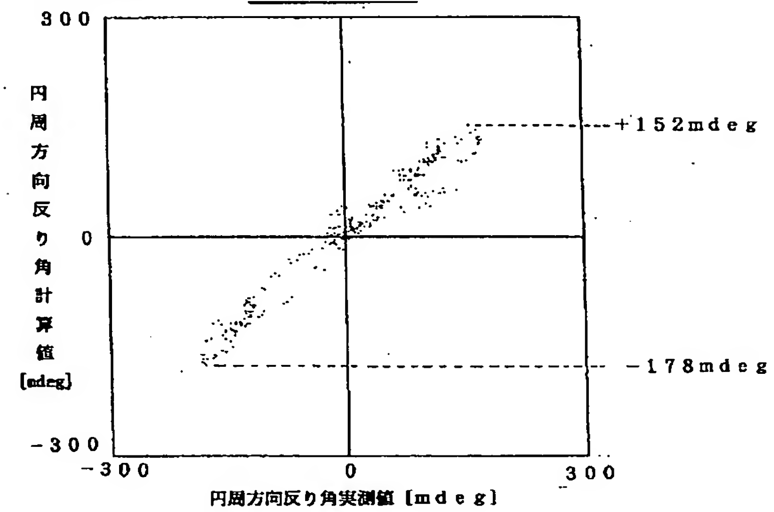
[Drawing 10]



[Drawing 11]



[Drawing 12]



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